ones are of the same type as those of *P. orientalis*, a vesicular gland with a narrow duct lying in the leg.

The only other particular in which my specimens differ from those of Prof. Bouvier is in respect to the female generative organs. In the two examples that he dissected there was little or no trace of a receptaculum seminis, but he points out that the ovaries were very large, thus making the dissection difficult.

In both the females that I dissected it was easy to trace the oviducts for the whole of their course, and shortly after their emergence from the ovarian sac, where they at once diverge from one another, there was a well-marked receptaculum seminis on each side, full of sperm. This is another point of resemblance between this species and *P. orientalis*, which seems on the whole to be the most nearly related form.

39. Field-Observations on the Enemies of Butterflies in Ceylon. By J. C. F. Fryer, M.A., F.E.S.; Fellow of Gonville and Caius College, Balfour Student in the University of Cambridge.*

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Ethology (Birds and Butterflies).

The subject of Birds and Butterflies in Ceylon has already been admirably dealt with by Col. N. Manders in his paper entitled "An Investigation into the Validity of Müllerian and other forms of Mimicry, with special reference to the Islands of Bourbon, Mauritius, and Ceylon"†. In spite of this, however, I venture to place on record a few further notes from the island, partly because they deal more fully with the butterfly-eating habits of a most interesting bird, the Wood-Swallow (*Artamus fuscus* Vieill.), but also because the subject, with its direct bearing on the various theories of mimicry, is essentially one which requires as many observations as possible before any fair generalisations can be made.

A residence of a year and nine months, largely devoted to entomological research, gave an opportunity for keeping a continual watch on certain of the more common insectivorous birds; and the following notes comprise every observation made during that period. The locality in each case, unless otherwise stated, is the celebrated Botanical Garden at Peradeniya‡. Other localities mentioned are Vavonia-Valunkulam, Maha Illupalama, and Trincomalee—all places in the hot dry northern country, which is characterised by the large area of jungle it contains,

* Communicated by Prof. J. Stanley Gardiner, M.A., F.R.S., F.Z.S.
† Proc. Zool. Soc. 1911, p. 696.
‡ Elevation about 1600 feet.

and also, in my experience, by a greater quantity of butterflies and other insect life than can usually be found in the hills.

The notes are given in chronological order, and are extracted from my journal practically without alteration, as this method, though possibly wearisome, places a check on the personal prejudices of the observer, the introduction of which it is difficult to avoid in a mere summary of results.

PERADENIYA.

1911. *April 7th.* A drongo * took a *Papilio polytes* Linn. ♂, which could hardly fly, as it had only just emerged; it then caught a *Melanitis ismene* Cram., also released soon after it had left the pupa.

April 2nd–9th. General note that "drongos were only observed to take small butterflies, chiefly *Yphthima ceylonica* Hewit., Lycænids, and occasionally *Precis iphita* Cram." "Of the various attempts quite one out of two missed their object, while in many cases the swoop at a butterfly seemed to be taken more for amusement than to gain food." "Paradise fly-catchers (*Terpsephone paradisi* Linn.) being more retiring, were harder to observe; they certainly took *Yphthima ceylonica* and small Lycænids, but were not observed to attack anything large." [This week, April 2nd–9th, was spent mainly in bird observations, and the above is the result.]

April 15th. A drongo was seen to attack *Catopsilia pyranthe* Linn., but apparently without success.

May 9th. A drongo was seen to take an *Yphthima ceylonica* in the garden. . . . Three drongos chased a *Papilio parinda* Moore, but did not catch it. . . . Two bulbuls (*Molpastes hæmorrhous* Gm.) chased an orange-coloured moth, probably *Argina* sp., but lost it.

June 25th. A Paradise fly-catcher swooped at a *Limenitis calidasa* Moore, which escaped.

July 9th. A magpie-robin (*Copsychus saularis* Linn.) took a specimen of the Chalcosiid moth, *Heterusia cingala* Moore †, and flew away with it.

October 16th. A drongo chased a *Papilio parinda*, but lost it.

October 19th. A drongo caught a *Papilio polytes* ♂, and ate it.

October 21st. A scanty *P.-polytes* migration for the last three days. . . . A drongo swooped at a *P. polytes* ♀ form *polytes* ‡, but missed it. Many females of the *romulus* form § with the entire hinder portion of the hind wings missing.

November 1st–15th (at Vavonia-Valunkulam). A continual migration of *Appias* (*A. paulina* Cram. and *A. albina* Boisd.),

* Throughout, the word "drongo" is used for either *Dicrurus leucopygialis* Blyth, or *D. cærulescens* Linn. The former was more common; but the species in most cases was not ascertained.

† This should undoubtedly be an "inedible" species, as it has all the Chalcosiid's nauseous characters to a marked degree.

‡ *P. polytes* ♀ *polytes* resembles *Papilio aristolochiæ* Fabr.

§ *P. polytes* ♀ *romulus* resembles *Papilio hector* Linn. Both *P. aristolochiæ* and *P. hector* are common Ceylon insects.

Catopsilia (*C. crocale* Cram. with a few *C. pyranthe* Linn.), *Papilio polytes*, *P. jason* Linn., *P. nomius* Esper, and *P. hector* Linn. Bee-eaters (*Merops* sp.?) were common, but were only observed to chase butterflies (*P. jason*, *Appias* sp.) on three occasions, each attempt being unsuccessful. Wings of all the above butterflies were found occasionally along the roads, but not in any number.

November 25th (at Peradeniya). A drongo seen to take a *Papilio polytes* ♀ *romulus*, which was flying badly.

November 29th. A number of wings of *Euplœa* and *Danais* found on the ground in the garden. The only birds seen near were wood-swallows (*Artamus fuscus* Vieill.). The wings identified were:—*Euplœa core* Cram., fore wings 6; *E. kollari* Feld., fore wings 2; *E. coreta* God., fore wing 1; *Danais septentrionis* Butl., fore wings 5, hind wings 3.

November 30th. Spent an hour, 11 A.M.–12, watching the wood-swallows hawking butterflies, which appeared to be forming their sole food. The birds sat on the top branches of a leafless tree, and swooped out after their prey, usually effecting a capture. The successful attempts were estimated at two out of three. The butterfly was carried to the perch and the wings there discarded. Butterflies on migration were extremely abundant, and individuals of the genus *Catopsilia* were perhaps most numerous, though Euplœas, Danaids, *Papilio polytes* and *P. demoleus* Linn. were all quite common. The wood-swallows limited themselves almost entirely to Euplœas and Danaids, only three swoops at *Catopsilia* and one at *Papilio demoleus* being observed, and these were all failures. The majority of the discarded wings were blown into the river, but the following were collected, practically all of which must have fallen during the morning.

Result:—*Danais septentrionalis*: fore wings 61, hind wings 9.
Euplœa core: fore wings 48.
E. coreta: ,, ,, 29.
E. kollari: ,, ,, 6.
Euplœine hind wings 9, fragments 4.
Papilio demoleus: fragments 2.
P. polytes ♂ or ♀ *cyrus*-form*: fragments 7 (2 fore wings).
P. polytes ♀ *romulus*: fragments 5 (3 fore wings).
P. polytes ♀ *polytes*: hind wing 1.

The predominance of fore wings is explained by their greater weight, hind wings being blown further.

A pair of bee-eeters were feeding near the wood-swallows. Most of their attacks were on small insects; but four attempts on *Catopsilia* and two on *Papilio demoleus* were noted, all of which failed. These bee-eaters were either unskilful or only amused themselves with butterflies. A young Paradise

* *Papilio polytes* ♀ *cyrus*-form resembles the ♂.

flycatcher and a drongo confined themselves to small insects, in spite of the swarms of butterflies passing.

December 1*st*. Again visited the wood-swallows, but they left off feeding early; the butterfly migration was larger, with a higher percentage of *Euplœa*. It was distinctly observed in one case that the bird carried the butterfly, a *Danais septentrionis*, to its perch and then held it with its feet while it pulled the wings off with its beak *. Watched the bee-eaters again, and saw one attack first a *Papilio agamemnon* Linn. and then a *Euplœa*, but it missed each time. They were continually hawking small insects, which they presumably caught. No count could be made of discarded wings, as all had been blown by a high wind into the river.

December 2*nd*. Again watched the wood-swallows hunting. The butterfly was always carried back to the perch before the wings were removed, and it was noticed that portions of the wings were often left on and eaten. . . . After failing in a stoop, the birds rarely made another at the same insect. . . . Butterflies at some distance were usually taken, perhaps to allow the bird to attain greater pace. . . . If a butterfly noticed that it was being pursued, it at once dodged and, flying rapidly downwards, frequently escaped. Wings were again collected :—

Danais septentrionis: fore wings 35.
D. limniace: „ „ 4.
Euplœa core: „ „ 18.
E. coreta: one whole insect and fore wings 10.
E. kollari: fore wings 4.
Papilio polytes ♀ *romulus*: fore wing 1.

December 7*th*. Wood-swallows hunting in the afternoon; they usually stop before midday.

December 10*th*. A young Paradise flycatcher swooped at two *Papilio polytes*, a ♂ and a ♀ *polytes* form, which were flying round inside a large breeding-cage, but of course could not get at them.

December 16*th*. A drongo was seen to attack a *Papilio agamemnon* and snap off a portion of the hind wings. The butterfly escaped.

1912. *January* 1*st*–6*th* (at Maha Illupalama). Bee-eaters were very common and butterflies, notably of the genera *Catopsilia* and *Appias*, were abundant. The only attack observed was that of a bee-eater on a *Leptosia xiphia* Fabr., which was caught and eaten.

January 10*th* (at Peradeniya). A drongo caught a *Papilio polytes* ♀ *cyrus*-form, which had just emerged and had escaped from a breeding-cage.

February 22*nd*. A *Papilio polytes* ♀ *cyrus* escaped from a cage and was eaten by a drongo; it was flying very weakly, as one wing was broken halfway down the costa.

* Legge, 'Birds of Ceylon,' vol. ii. p. 668, states that the wood-swallow beats off the wings of its prey.

March 6*th*. Noticed three wood-swallows sitting on the telephone-wires crossing the River Maha-Weliganga. They were hawking butterflies continually, and during the time they were watched selected species of *Euplœa* only from a passing migration which consisted largely of *Appias paulina*. A search for wings failed, as the birds confined themselves entirely to the river. The reason for this seemed to be that the butterflies were only caught with ease when away from cover; among vegetation they dodged their pursuers nine times out of ten. This fact was specially evident during this migration, as species of *Euplœa* and *Danais* were uncommon, and the birds were often forced to swoop at butterflies travelling along the river-bank instead of waiting for individuals to come out into the open.

March 8*th*. The migration of butterflies almost ended; but to obtain confirmation, by a fresh witness, of the fact that wood-swallows attack especially members of the genera *Euplœa* and *Danais*, Alexander * and I watched three wood-swallows for an hour, and we both plainly observed them eat over a dozen *Euplœa* and one *Danais*. We also saw one bird with a *Papilio*, either *P. polytes* ♀ *polytes* or *P. aristolochiæ*, but were unable to ascertain which. As before, the birds usually carried the butterfly in the beak, though occasionally it was transferred to the claws when the distance back to the perch was great.

March 15*th*. Watched the wood-swallows for three-quarters of an hour; *Appias* spp. common, *Euplœa* and *Danais* scarce. There were only two birds feeding, one probably young, for when the other caught a *Danais aglœa* Cram. the young one opened its beak and fluttered its wings as if asking for food, though it gained nothing by this proceeding. The old bird then ceased feeding, but the other, possibly encouraged by the sight of the *Danais*, worked steadily, soaring round in circles over the river. It caught five Euplœas out of seven attempts.

March 16*th*. Watched a wood-swallow for a quarter of an hour and saw it take two Euplœas.

March 17*th*. Watched a wood-swallow from 11.30–12. It took two Euplœas, but then seemed to have no room for more, as it sat for a long time with the abdomen of the last victim protruding from its mouth like a cigar.

March 18*th*. In five minutes saw two wood-swallows take three Euplœas and a *Papilio*, either *P. polytes* ♀ *polytes* or *P. aristolochiæ*, almost certainly the former.

March 22*nd*. Species of *Euplœa* and *Danais* abundant on migration. A wood-swallow picked out two Danaids (*D. limniace* and *D. septentrionis*) and then a *Euplœa*, after which it stopped feeding.

March 23*rd*. Watched the wood-swallows from 11.40 A.M.–12; two were under observation most of the time, occasionally four. They took six specimens of *Euplœa* and two *D. septentrionis*.

* Mr. Alexander, Assistant Curator of the Perth Museum, W.A., to whom I am indebted for much critical assistance during his brief visit to the island.

April 23rd. A drongo swooped at and probably took either a *Papilio polytes* ♀ *polytes* or a *P. aristolochiæ.*

April 24th. Mr. Pole of Maskeliya * wrote that he saw two large dragonflies take two *Appias* sp. ? and one *P. polytes* ♂.

July 7th (at Maha Illupalama). Noticed the remains of *Danais septentrionis*, *Papilio jason*, *Appias paulina* and *A. albina*, killed probably by Asilid flies (*Scleropogon piceus* and other species), as the bodies were intact though empty. Asilid flies were twice seen carrying *Appias* sp. ? ♂.

August 8th (at Maha Illupalama). Caught an Asilid fly with a medium-sized dragonfly †, which it was sucking through the eye, and later saw another Asilid killing a large *Cicada* ♂ which was flying madly about, shrieking (stridulating) all the time. A slight bite from an Asilid was most painful, and felt as if poisonous matter had been injected.

August 13th (at Maha Illupalama). Noticed Asilid flies kill *Appias* sp. ? ♂ and *Papilio jason.*

August 28th (at Habarana, Maha Illupalama District). An Asilid attempted to kill the formidable Ceylon hornet, *Vespa cincta*, which, however, escaped.

August 31st (at Trincomalee). A few *Euplœa* wings were found scattered about Fort Ostenburg; they were probably dropped by wood-swallows, which were hawking round the inner harbour.

September 1st (Trincomalee). On the Nilavelli-Kuchivelli road bee-eaters were numerous. One was seen to catch an *Appias* sp., and wings of *Euplœa*, *P. jason*, and *Appias* spp. were occasionally found on the ground.

September 7th (at Peradeniya). Released an *Actias selene* ♂. It flew fairly well, but was soon snapped up by a drongo, which, before eating it, first pulled off the "tails" and then the rest of the wings.

The observations having now been given at length, it is perhaps permissible to summarise the impressions gained in their making:—

i. Butterflies do not form any large percentage of the food of the more common insectivorous birds in Ceylon.

ii. With the exception of the Wood-Swallow, birds are by no means clever in capturing butterflies.

iii. The Wood-Swallow is the only bird which actually lives on butterflies, and it almost always chooses butterflies of the so-called nauseous genera *Danais* and *Euplœa*; it seemed, however, that this preference was due to the difficulty of catching faster-flying butterflies, and not to the superior flavour of the *Danais* or *Euplœa.*

* Hill district, elevation about 4000 feet.

† This and one or two subsequent notes, though not dealing with butterflies, are included, as they seem worthy of record and yet are insufficient for a separate contribution.